

WHAT IS CLAIMED IS

1. A plasma processing system comprising:
  - a processing chamber into and from which processing gas is 5 inlet and outlet;
  - a pair of electrodes disposed so as to mutually oppose within said processing chamber;
  - a RF feeding apparatus for generating plasma between said pair of electrodes;
- 10 a retaining/removal apparatus for retaining a substrate to be processed on and removal from a sample table while one of said pair of electrodes is taken as the sample table; and
- 15 a detection apparatus for detecting the electrostatic-chucking state of the substrate and for detecting removal state of electrical charges from the substrate, on the basis of variations in impedance arising between the sample table and the substrate.
- 20 2. The plasma processing system according to claim 1, wherein said detection apparatus has an impedance detection circuit connected to a power line of said RF feeding apparatus and to a power line of said retaining/removal apparatus by way of a voltage probe, said impedance detection circuit detecting plasma impedance stemming from variations in the length of a gap between the sample table and the substrate, said impedance detection circuit detecting an electrostatic chucking failure or the end of removal of electrical charges.
- 25 3. The plasma processing system according to claim 1, wherein said retaining/removal apparatus has an insulating coating provided on the surface of the sample table on which the substrate is retained, said retaining/removal apparatus having a DC application apparatus for applying a DC voltage to the sample table:
  - the substrate is chucked and retained by the sample table by means of the electrostatic force developing between the substrate and the sample table, the plasma being taken as ground: and
  - 35 the electrical charges, which are still remained on the substrate and on the insulating coating formed on the sample table, are removed by means of applying, to the sample table, a voltage for generating electrical charges opposite in polarity to those accumulated on the substrate and those on the insulating coating of

the sample table, the substrate being removed from the sample table.

4. The plasma processing system according to claim 1, wherein  
said RF feeding apparatus feeds a high-frequency output for producing  
5 the plasma, within a range of at least 1 W to 2.0 KW.

5. The plasma processing system according to claim 1, wherein  
said retaining/removal apparatus outputs a chucking voltage for  
10 retaining the substrate and outputs a charge-removal voltage for  
removal the substrate, in the form of a DC voltage within a range  
of -2.0 KV to 2.0 KV.

6. The plasma processing system according to claim 2, wherein  
said detection apparatus detects variations in plasma impedance when  
15 the length of a gap between the substrate and the sample table is  
changed within a range of 0.5 to 15 mm.

7. The plasma processing system according to claim 2, wherein  
said detection apparatus detects a change in plasma impedance on the  
20 basis of variations in the length of the gap between the substrate  
and the sample table, the sample table being lowered under lowering  
pressure of cooling gas inlet from the sample table, said detection  
apparatus detecting an electrostatic chucking failure.

25 8. The plasma processing system according to claim 3, wherein  
said retaining/removal apparatus has, as an alternative to the DC  
voltage application apparatus, a position detection sensor and a  
vertically-slidable actuator, said vertically-slidable actuator  
removing the substrate from the sample table on the basis of an output  
30 from the position detection sensor.

9. A plasma processing method for inletting processing gas  
between a pair of electrodes disposed so as to mutually oppose within  
35 a processing chamber, the processing gas being discharged from the  
processing chamber after processing of a substrate to be processed,  
the method comprising the steps of:

generating plasma between the pair of electrodes;  
retaining the substrate on a sample table by means of  
40 electrostatic chucking while one of the pair of electrodes is taken  
as the sample table;

removing the substrate from the sample table by means of removing residual electrical charges from the substrate; and

detecting electrostatic chucking state of the substrate and removal state of electrical charges from the substrate, on the basis 5 of variations in impedance between the sample table and the substrate.

10. The plasma processing method according to claim 9, wherein in said step for retaining, plasma impedance varies for reasons of variations in the length of a gap between the substrate and the sample 10 table.

11. The plasma processing method according to claim 10, wherein in said step for retaining, the plasma impedance varies when the length of the gap between the substrate and the sample table changes within 15 a range of 0.5 to 15 mm.

12. The plasma processing method according to claim 9, wherein in said step for retaining, plasma impedance varies in accordance with variations in the length of a gap between the substrate and the 20 sample table lowered under lowering pressure of cooling gas inlet from the sample table, the plasma impedance arising between the sample table and the substrate.

13. The plasma processing method according to claim 9, wherein 25 in said step for removing, plasma impedance varies for reasons of variations in the length of a gap arising between the substrate and the sample table.

14. The plasma processing method according to claim 13, wherein 30 in said step for removing, the plasma impedance changes when the length of the gap arising between the substrate and the sample table changes within a range of 0.5 to 15 mm.

15. The plasma processing method according to claim 9, wherein 35 in said step for removing, plasma impedance changes in accordance with variations in the length of a gap developing between the substrate and the sample table, the sample table being lowered under lowering pressure of cooling gas inlet from the sample table.

40 16. The plasma processing method according to claim 9, wherein

in said step for detecting, variations in plasma impedance stemming from variations in the length of a gap between the substrate and the sample table are detected, the end of removal of electrical charges being detected.

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17. A method of manufacturing a semiconductor device using the plasma processing system according to claim 1.

18. A method of manufacturing a semiconductor device using  
10 the plasma processing method according to claim 9.